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TITLE

FIELD WORK DEALING WITH EATSUCOCCUS STUDIES

AT THE MACHANICS AND HALL'S FLAT LABORATORIES.

Season of 1940

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by
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Berkeley, California
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SUBJECT—

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# FIELD WORK DEALING WITH MATSUCOCCUS STUDIES AT THE HACKAMORE AND HALL'S FLAT LABORATORIES.

Season of 1940

## INTRODUCTION

At the Hackamore Field Laboratory of the U. S. Bureau of Entomology and Plant Quarantine, field work on several phases of the Matsucoccus pine scale problem was carried on during the early summer months of May and June, 1940. The work, begun on May 2, was directed and supervised by H. L. McKenzie, the work in the field being performed for the most part by J. W. Johnson with the assistance of a crew of CCC enrollees from the Hackamore CCC camp. With the closing of the Hackamore laboratory in late June, the work was terminated, but collections for the life history study were continued at the Black's Mountain Forest and Range Experiment Station, Lassen County, California.

Special acknowledgement of thanks is made to the Modoc National Forest office and personnel for their cooperation and the provision of CCC labor to assist in the program, and also to the Shaw-Bertram Lumber Company of Klamath Falls, Oregon, which gave the Bureau permission to use the trees felled in their logging operations as a source of material and information for the Hackamore studies.

## ORGANIZATION OF THE FIELD WORK

The field work was distributed over three distinct problems:

1. A survey of the distribution of Matsucoccus populations (a) in the crowns of Risk 1 and Risk 4 ponderosa pine trees, and (b) in unhealthy areas of crowns.

2. A study of the life histories and species of Matsucoccus pine scales on ponderosa pines of the eastside area.

3. The testing of the effects on the conductive properties of the twig stems of injuries to the plant tissues associated with the presence of Matsucoccus scales.

## MATSUCOCCUS PINE SCALE POPULATION SURVEYS

### Objectives

The population surveys had two objectives:

1. The determination of the nature of the distribution of Matsucoccus populations in a number of trees in very good health (Risk 1 trees), and in a number of trees in very poor health (Risk 4 trees).

2. The determination of the distribution and numbers of scales in relation to areas of tree crowns showing conspicuous deterioration and flagging.

### Selection and Source of Trees

Only [redacted] freshly-felled trees that were assignable without question to the Risk 1 and Risk 4 health classes were used for sampling purposes. These were selected while they were standing and in natural relationship to surrounding trees.

### Numbering of Trees

The same series of trees was used for sampling for both phases of the survey problem; hence only one set of records was needed, and only one number sequence was used. Each tree selected for sampling was assigned a number consecutive in a series beginning with 1. The number was preceded by the initial M (for Matsucoccus) and succeeded by the number 40, which stood for the year of collection. The first number issued to a tree, for example, was M-1-40. The total series comprised 63 trees.

### Sampling and Collection Methods

For the two objectives of the survey, different sampling methods were used. For both, each sample consisted of a branch or a portion of a branch from perhaps four to six feet in length and two to three inches in diameter, and bearing a number of smaller branches and twigs carrying green foliage. These sample branches were cut from the tree soon after it had been felled and before the limbers had trimmed the branches from the bole.

For the general survey of Risk 1 and 4 trees each tree was sampled three times by selecting at random one branch from the top crown, one from the mid-crown, and one from the lower crown. These branches for objective 1 were designated as an A series from each tree, and each branch was tagged or marked with the tree number, the series letter A, and the letter indicating its position in the crown - as T for top, M for mid-crown, or L for lower crown.

The series of branches collected for the second objective were taken from areas in the crown showing local injury and constituted a B series from each tree so sampled. Each branch was marked with the tree number, series letter B, and the crown position letter.

Recording of Data

The data recorded for each tree sampled was that which appears on the Black's Mountain Tree Analysis and Susceptibility Project form. A sketch of each tree made while the tree was standing was included on the form, and unusual crown features such as dead areas, flagging, or an old top-kill were indicated. With completion of sampling, the points from which branches were taken for both the A and B series were indicated on the sketch. In addition to the sampling for Matsucoccus, the bark and phloem of the bole were examined, and the distribution and relative abundance of insect infestations in the phloem of the bole were recorded in the spaces for stem analysis notes (see sample forms attached below).

SUSCEPTIBILITY PROJECT - BLACK HILLS MOUNTAIN EXPERIMENTAL FOREST

Tree Number M-38-40 Compartment No. Mud Lake Date of Obser. June 4, 1940

| DOMINANCE | AGE | CROWN LENGTH | CROWN SYMMETRY | CROWN WIDTH | TOP SHAPE |
|---|---|---|---|---|---|
| Dom. x | Young | 1/4 | Symmetrical x | Wide | Pointed |
| Cod. | Immat. | 1/2 | Onesided | Medium x | Rounded x |
| Int. | Mature | 3/4 x | Irregular | Narrow | Flat |
| Sup. | O'r Mat. x | | | | |

| APPEARANCE | CROWN DENSITY | | NEEDLE LENGTH | | NEEDLE COLOR |
|---|---|---|---|---|---|
| | Top: | Mid-Crown | Top: | Mid-Crown | (Green) |
| Excellent | | | | | |
| Good | Dense | Dense | Long | Long | Dark x |
| Fair | Medium | Medium x to | Medium x to | Medium x to | Light x |
| Poor x | Thin x | Thin x | Short x | Short x | Yellow |

| TWIG INJURY | BRANCH INJURY | % TOP-KILLED |
|---|---|---|
| None | None | Current 0 |
| Light | Light | Old 16% |
| Moderate | Moderate | |
| Severe x | Severe x | |

REMARKS Old TK. Considerable old loss through crown. Foliage bunchy. Needles short, reduced complements. Current flags in branches below TK, and in mid and lower crown. FH expected in upper 10-15 feet of bole below TK.

(Record place in crown of apparent weakness and predict presence or absence of FH incipients)

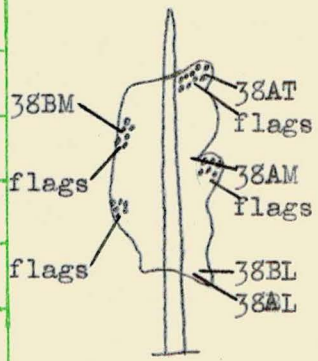
Tree No. M-38-40

TREE ANALYSIS - SUSCEPTIBILITY PROJECT - BLACK'S MOUNTAIN EXPERIMENTAL FOREST

Tree Sp: P.P. Keen: 4B FH Intensity FH Success Compartment No. Mud lake
DBH: 34" Dunning: 5 1. 1. x Date Felled: June 7, 1940
Vol: length 96' Suscep: 4 2. 2. x Date Examined: June 7, 1940
3. x 3. x Examiner: J.W.J.

| Sec. No. | Diam Base | Diam. Top Ht. ~~xx~~ | ~~Bark Area~~ xxxx | Insects | Remarks |
|---|---|---|---|---|---|
| A | 3.0' | .9' | 81' | FH incipients living & successful - heavy numbers. A 20-foot strip kill on west side of A below old TK. | |
| B | .9' | .3' | 15' | Old TK. FH emergence holes abundant. | |
| | | | | | |
| | | | | Progressive FH infestation. Lower end of strip kill of recent date. FH work observed in it, and bark contains pupal cells. | |
| | | | | | |

Sketch




B-30

## Numbers of Trees Examined and Sources of Trees

Sixty-three trees were used for sampling. Of these, 32 were risk 1's and 31 were Risk 4's. These trees were located in two areas. One was northwest of Hackamore about 3/4 of a mile and consisted of both virgin forest and part of an area in which the Shaw-Bertram Lumber Company was carrying on logging operations. The other was in the vicinity of Mud Lake about 7 miles south of Hackamore where the Shaw-Bertram Lumber Company was cutting also.

In the vicinity of Hackamore 21 trees were utilized for sampling - 6 in the area of cutting, and 15 (Risk 4 trees which were felled by Johnson and CCC crew) in the virgin forest near the edge of the cut-over land. At Mud Lake 42 trees were utilized, 21 in an area 1½ miles south of the Lake, and the other 21 near the south and western shores of the Lake (see Table 1).

Table 1. Sources of High and Low Risk Trees Sampled in Matsucoccus Survey

| Source Area | Low Risk | High Risk | Total No. Trees |
|---|---|---|---|
| Hackamore cutting | 4 | 2 | 6 |
| Hackamore virgin | | 15 | 15 |
| Mud Lake southern area | 9 | 12 | 21 |
| Mud Lake adjacent to Lake | 19 | 2 | 21 |
| Total | 32 | 31 | 63 |

## Labor

A crew comprising 2 to 4 enrollees from the Hackamore CCC Camp assisted in the Bureau work program. These were made available by arrangement with the Modoc Forest Service office and with Mr. Kauffman, Forest Service Superintendent of the Hackamore CCC Camp. About 237 CCC man hours were expended directly on the Matsucoccus studies, the work being divided between the tasks of gathering the branches in the field, and of preparing them for shipment to Berkeley.

## Disposal of the Branches

Following collection, labeling and transporting of the branches to the laboratory, they were then sorted and tied in bundles, all branches from each tree being bundled together. These bundles in turn were tied together in larger bundles, which were then wrapped in heavy paper and burlap. From Hackamore the bundles were shipped to Berkeley where a critical microscopic examination of the scale populations was being made.

## MATSUCOCCUS LIFE HISTORY STUDY

### Objective

The life history study had as its objective the regular examination of living populations of Matsucoccus for the purpose of observing the stages of the life histories of the species on the ponderosa pine. A collection of dead scale was made also for the purpose of determining the species of Matsucoccus concerned. The field work required by this problem was the regular collection of ponderosa pine branches carrying infestations and the shipping of these to Berkeley for examination.

### Collections

With few exceptions branches were collected each week from living standing trees or from recently cut trees. Collections were made in the vicinity of Hackamore during the months of May and June. Following the closing of the Hackamore laboratory, the weekly collections were continued in the vicinity of the Black's Mountain Forest and Range Experiment Station; and in October two final collections were made again at Hackamore (see Table 2).

Table 2. Location and Condition of Trees Used for Life History Collections

| Area | Pole Size | Immature | Mature | Over-mature | Total No. Trees | Risk 2 | Risk 4 or Infested |
|---|---|---|---|---|---|---|---|
| Modoc: | | | | | | | |
| Hackamore | 2 | | 2 | | 4 | | 4 |
| Timber Mt. | | 1 | 2 | 1 | 4 | | 4 |
| Mud Lake | | | | 1 | 1 | | 1 |
| Plum Ridge | 5 | | | | 5 | | 5 |
| Deer Hill | 1 | | | | 1 | | 1 |
| Badger | | | 1 | | 1 | | 1 |
| Lassen: | | | | | | | |
| Black's Mt. | 2 | 1 | 3 | 10 | 16 | 1 | 15 |
| Totals | 10 | 2 | 8 | 12 | 32 | 1 | 31 |

The Hackamore collections were made for the most part from pole-sized trees that gave evidence of carrying infestations. But several collections were made from immature, mature and overmature Risk 4 trees.

With the transference of activities to the Black's Mountain Experiment Station, collections were made for the most part from recently felled overmature Risk 4 trees, but two collections were taken from poles, and one from an immature tree, and several from mature trees.

Records

For each tree used as a source of branches, notes were taken on the apparent condition of the tree, and for the trees over 12 inches in diameter, the Keen and Dunning tree classes, Risk rating, and diameters were recorded. Each tree was assigned a serial number consisting of the letters LH (life history) and a number consecutive in the series beginning with 1; e.g., LH-1, LH-2, etc. A total of 32 collections was made. Each branch as it was collected was marked with the number of the tree from which it was taken.

Disposal of Collections

Collections were made for the most part at the end of the week. The branches were then promptly shipped to Berkeley for examination.

## CONDUCTION STUDY

Objective

The third problem for which field and laboratory work was planned was the determination of the effects on the conductive properties of the ponderosa pine twig stems of injuries to the plant tissues associated with the presence of Matsucoccus scales.

Plan of Work

Two series of experiments were planned:

1. The use of stain injection techniques with the stains acid fuchsin, methylene blue, scarlet red, water green, and silver nitrate to demonstrate whether there was a visible physical blocking of the conduction in injured tissues.

2. The measurement by pressure injection of rates of liquid flow through selected samples of uninfested and infested twigs to determine whether quantitative differences in conductivity of the stems could be detected and demonstrated. The second series was further divided into tests using staining solutions for the porpose of determining rates of penetration of solutions through twigs, and tests using volumetric apparatus to measure the quantity of liquid passing through stems in given periods of time.

## Materials

The branches and twigs to be used for the injection tests were to be selected from Risk 1 and Risk 4 trees, either from standing trees or from those which were newly felled. The material would be used promptly after its collection.

## Records

In addition to the records of the experiments, a record of the condition of each tree with respect to the characters included on the Black's Mountain Tree Analysis and Susceptibility Project form would be kept. The trees that were used as sources would be numbered consecutively, the serial number being composed of a letter C (for conduction) followed by the consecutive number, followed by 40 (for the year); e.g. C-1-40, etc.

## Comparisons To Be Made

By means of the several kinds of tests comparisons were to be made between the conductivity of twigs from Risk 1 trees and from Risk 4 trees and between the conductivity of infested twigs and uninfested twigs. For the second comparison it would be necessary, in order to make the two series of twigs more comparable, to pair the infested twigs with control samples taken from the same tree and from as near the same portions of the crown as possible. This practice would prevent the influence of factors arising from differences between trees, were the pairs to be made up from twigs taken from different trees.

## Work Done in 1940 Season

In the 1940 season only a few testings were made, these for the purpose of trying out different techniques and discovering the problems that must be overcome prior to the carrying out of a final series of tests.

Staining tests with silver nitrate were carried out on 34 twigs. These tests indicated that the stain behaved in the twigs in a fashion similar to that in wood blocks in the series of tests run in 1939 using flathead-scarred wood. It was not possible to make further tests with the other stains.

With respect to the testing of rates of conduction, No tests with stain solutions were made. But the conduction rates of five pine stems were tested volumetrically under a hydrostatic pressure of about one quarter atmosphere (see Table 3, page 8). These several tests were purely exploratory. The twigs were taken from healthy trees, and no examination was made prior to testing to determine whether these stems carried scale infestations. One of the stems, the first tested, had somewhat scarred and roughened bark, and came from the lower crown of a vigorous tree. The remaining four stems were from the mid-crowns of vigorous trees.

Table 3. Record of Volumetric Tests of Conductivity of Several Pine Twigs

| Sample Number | Position in tree crown (Risk 1 trees) | Condition of Twig | Duration of injection (in min.) | Water collected in burette (in cc.) | Length of twig (in in.) | Diameter of twig at upper end (in in.) | Cross-sectional area of upper end of twig (in sq. in.) | Conductivity per sq. in. per minute (in cc.) |
|---|---|---|---|---|---|---|---|---|
| 1-main fork | Lower crown | Bark rough Twig forked | 212 | 6.10 | 7.6 (stem&fork) | .28 | .062 | .47 |
| 1-side fork | Lower crown | Bark rough Twig forked | 212 | 3.00 | 6.1 (stem&fork) | .19 | .028 | .49 |
| 1-both forks | Lower crown | Bark rough Twig forked | 212 | 9.10 | --- | --- | .090 | .48 |
| 2 | - - - - - - - - - - - - - - - - | | transpiration-potometer experiment - discontinued | | | | | - - - - - - - - - - |
| 3 | - - - - - - - - - - - - - - - - | | transpiration-potometer experiment - discontinued | | | | | - - - - - - - - - - |
| 4 | Mid-crown | Normal Unforked | 167 | 54.15 | 11.0 | .47 | .17 | 1.85 |
| 5 | Same tree, same branch as in 4 | Normal Unforked | 47 | 26.30 | 5.7 | .44 | .15 | 3.68 |
| 6 | Mid-crown | Normal Unforked | 100 | 16.90 | 11.9 | .43 | .15 | 1.17 |
| 7 | Same tree, same branch as in 6 | Normal Unforked | 100 | 11.05 | 11.8 | .35 | .096 | 1.14 |

The first stem, which was forked, shows markedly lower conductivity, as calculated in terms of the cross-sectional area and in a unit period of time, than the other stems. Numbers 4 and 5 were from the same branch of a second tree, but the stem number 5 was cut to approximately one-half of the length of stem number 4. The conductivity of the two stems shows an opposite relationship, with number 5 having twice the conductivity of number 4. This difference might possibly be the result of the difference in internal resistance of the two stems to the movement of water through them, the longer stem having the greater resistance. Stems 6 and 7 were taken from the same branch of a third tree and were approximately equal in length. The conductivity of these two stems is also very nearly the same.

As a result of these tests, it was demonstrated that even under the low pressure that was used, the rate of water movement through the stems was quite rapid and could be readily measured by the apparatus that it was proposed to use. The five stems were saved following the tests, and they will be examined to determine if they were infested with scales and the densities of the populations.

But two changes are recommended in the volumetric apparatus:

1. Heavy-walled, unexpandable rubber tubing should be used throughout the apparatus with the exception of the pieces that slip over the ends of the twigs. The heavy walled tubing is suggested in place of the thin-walled tubing used in the first experiments. It will necessitate the use of glass stop-cocks and glass-tubing unions for controlling the flow of the solution, in place of simple spring tubing clamps.

2. A source of steady, uniform pressure should be developed for the injection work to replace the simple hydrostatic pressure supplied by the elevated reservoir. The hydrostatic pressure was subject to some variation depending on the height of the water column in the elevated reservoir.

In selecting material for the tests it will be necessary to use particular care to secure with certainty and accuracy material that is known to be either well-infested or free from infestation, if clear-cut experimental results are to be obtained. It will be necessary, also, to have the infested and control series of branches as nearly comparable as possible with the exception of the conditions of infestation and injury that it is desired to test.

## TERMINATION OF THE WORK

Work at the Hackamore laboratory on phases of the Matsucoccus problem was terminated on June 26, 1940. In October two final collections of branches for the life history studies were made in the vicinity of Hackamore.

Respectfully submitted,

Berkeley, California
November 25, 1940

John W. Johnson
Agent